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ABSTRACT

While electronic learning environments provide exciting possibilities for supporting learners, the design of the user interface is as yet little understood. The purpose of this paper is to investigate the importance of specific usability attributes for online learning courses. A review of related papers on usability methods and learning theories is presented. The results of a usability study evaluating the use of a virtual learning environment providing distance learning for postgraduate studies in three Greek universities using WebCT, a well-known e-learning delivery platform, are presented. The review and the results of the study point towards specific usability attributes that need to be considered while designing usable learner-centered interfaces. (Contains 19 references.) (Author)

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On-line Learning Courses: A review and usability attributes

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ABSTRACT
While electronic learning environments provide exciting possibilities for supporting learners, the design of the user-interface is as yet little understood. The purpose of this paper is to investigate the importance of specific usability attributes for on-line learning courses. To realize this authors first content the need for designing learner-centered interfaces. A review of related papers on usability methods used and learning theories is presented. The results of a usability study evaluating the use of a Virtual Learning Environment providing Distance Learning for Post-Graduate studies in three Greek Universities using WebCT, a well-known elearning delivery platform, are presented. Finally, the review and the results of the study point towards specific usability attributes that need to be considered while designing usable learner-centered interfaces.

Keywords
On-line learning course, usability, learning theories, learner-centered interface, usability techniques, usability attributes.

1. INTRODUCTION

As information and communications technologies become more and more pervasive, expectations for educational computing are becoming greater and greater. Advances in electronic and web-based technologies offer online learning courses for learners (either students in educational settings or young professionals in organizational contexts) the opportunity to become skillful and acquire knowledge. There is an expectation that these technological advancements will make education and training available to a much wider audience of learners with diverse backgrounds and ages.

Given the importance of online educational computing for learning, *the need for evaluation of these technologies* becomes crucial (Jones et al., 1999). Squires (1999) points out clearly the need for *integration of usability and learning* as "*workers in HCI and educational computing areas rarely speak to each other or take note of each others' work: the educational computing literature is littered with naive and simplistic interpretations of interface design issues, and many writers in the HCI literature appear to be unaware of the significant developments that have been made in theories of learning*". Squires and Preece (1999) further argue that scholars have not considered the implications of usability features of an educational package in order to achieve educational goals: being educationally *beneficial*. Along the same vein Cronje (2001) asserts that "*although learning on the Internet is becoming more and more usual, it would seem that most of it still takes the form of virtual lectures*".

It is important in such environments to understand how usability contributes (or not) to educational goals (Jones et al., 1999). To this end, this paper argues that there is a need for usability scholars to consider the way in which usability and learning (special emphasis on user interfaces of on-line learning courses), interact. It is therefore, the aim of this paper to examine specific usability attributes that need to be considered.

To address this issue the paper is divided into 3 sections.

2. THE IMPORTANCE OF USABILITY FOR ON-LINE LEARNING COURSESS

The authors content that while designing on-line learning courses one needs to consider the usability of a web user interface. In this paper it is argued that usability of an on-line course's user interface can significantly affect learning.

In order to address the issue of usability one needs first to define the context of use of an on-line course. Increase in the diversity of learners, technological advancements and radical changes in learning tasks (learner interaction with a learning/training environment is often an one-time event); present significant challenges and render the possibility of defining the context of use of online learning courses. It is of great importance to point out that unlike users of a traditional software

product return time and again and gradually learn the interface, the instructional interface must make sense quickly since the user is unlikely to use the environment for an extended period of time.

Thus a good starting point would be to pose the following questions: What is the role of usability in the context of modern educational software design? Which usability attributes affect on-line learning?

To answer the first question these authors provide a review of learning theories and usability techniques and how these are used to improve the user interface of on-line learning courses. The results of this review will be used to conduct a usability study aiming at identifying usability attributes that affect users in on-line learning, thus answering the second question.

2.1 Applying Learning Theories

Chalmers (2000) links learning theories as well as instructional theories in order to present potential user interface improvements for research and development of computer-assisted instruction interfaces. This author suggests allowing quantification of observable results into the screen, use table of contents and the ability to link a chapter with the other chapter can be applications of behaviorism and cognitive learning theory respectively that can lead to learning.

Norman and Spohrer (1996) combine constructivism and problem-based learning with learner-centered approach: places the learner at the center of the interface design. Using constructivism theory learners are motivated to seek out new knowledge when they confront real problems at hand. The goal is active exploration, construction and learning and not the passivity of the lecture attendance and textbook reading. Norman and Spohrer (1996) assert that while this philosophy is not new the current applications are. The ideas of active exploration and construction of meaning as well as the motivation to solve real problems in authentic contexts are here for ages. These authors focus their analysis on three dimensions of instruction: engagement, effectiveness and viability. Engagement is tightly associated with motivation and the provision of rapid compelling interaction and feedback help make learners motivated and engaged. Effectiveness is a major concern because after all, learning as such is the most critical issue. Viability includes the issue of scalability, the technological infrastructure (authoring tools, design tools, component software standards etc) as well as the social and cultural one (integration into existing learning/training activities etc).

While learning theories can be applied to design on-line courses still the question remains (Dringus, 1995b): How does an instructor know that the course interface provides full potential for students to access and utilize the information that is being presented? Evaluations of online learning courses should include learners' perceptions about the course interface as well.

Application of learning theories onto the design of online learning courses' user interfaces cannot give answers to usability scholars. In fact Chalmers (2000) stresses we neither know *"...if we can generalize learning theories from the classroom to the computer lab"* nor *"...if we can generalize instructional theories from the text to a software tutorial"*. Further research needs to be conducted before these conclusions can be drawn.

Systematic evaluation of the efficacy of various media integrations and the usability of the interface and its functional components is missing. To this end, the next section reviews current usability evaluation techniques as they have been applied on on-line learning courses.

2.2 Applying Usability Evaluation Techniques

Parlangeli et al. (1999) conducted three studies: a heuristic evaluation, a usability test, learning assessment; regarding the evaluation of the multimedia course. The results of the usability test (using ten people) revealed many usability problems similar to those identified by the heuristic evaluation. The perceived low-level usability resulted by both studies have had a common denominator: scantly usable hypertextual structure. Additionally Parlangeli et al. conducted a third study focused on learning assessment. To evaluate the effects of learning using the multimedia course, given that this course evaluated as a poorly usable system, the learning performance of three homogeneous groups of students performing the same tasks although working with different tools was considered. These tools (a CD, a book and printed materials of the CD) were allotted to each student group. When the learning phase was completed, the students were given a multiple-choice test to assess their performance. There was no significant difference in the learning performance among the three groups of students.

Evaluating learning may move usability practitioners outside their comfort zone. In order for usability evaluation techniques to be more effective, they need to familiarize themselves with the evaluation frameworks and methods from instructional design (Lohr, 2000). Also essential are acquaintance with educational testing research (Rovai, 2000), learning styles (Terrell and Dringus 2000; Kolb 1984), and the rudiments of learning theory (Lin and Hsieh, 2001).

Web design heuristics that have grown up around e-commerce can also be used to evaluate online learning courses. Dringus (1995b) proposes that usability heuristics suggested by Shneiderman (1987) and Nielsen (1993) can be applied to evaluate on-line course interfaces. However, these heuristics should be used with caution since many assumptions about the users of e-commerce do not apply to on-line learners. The challenge for most types of on-line learning is that established sets of

heuristics do not exist. Pedagogical guidelines typically have to be developed that will be combined with the aforementioned heuristics.

Towards this direction Squires and Preece (1999) realized that simple application of these heuristics could not be effective because they fail to address the specific challenges of learner centered interface design as well as the issue of integration of usability and learning. Thus, these authors proposed an adaptation of Nielsen's (1993) heuristics, taking into account socio-constructivism tenets (Phillips, 1995; Soloway et al., 1996). The proposed set of "learning with software" heuristics contains the following:

- Match between designer and learner models
- Navigat.onal fidelity
- Appropriate levels of learner control
- Prevention of peripheral cognitive errors
- Understandable and meaningful symbolic representations
- Support personally significant approaches to learning
- Strategies for cognitive error recognition, diagnosis and recovery
- Match with the curriculum

These authors do not claim that this is a final set of heuristics. Rather it is an initial attempt towards integration of usability and learning that needs further discussion and elaboration.

Finally, established sets of principles of what works for on-line learning, based on research findings or industry best practices, do not yet exist. The usability standards and tests that have proven their worthiness for e-commerce and other applications need to be transformed before being applied to on-line learning tools and applications. However, some preliminary attempts towards this direction have been made and will be further discussed.

Relevant to *navigational fidelity* is the work conducted by Parlangeli et al. (1999). The working hypothesis was that the level of usability of an online course could affect the learning performance. The results indicated that students' knowledge related to the content of the course under evaluation was not higher after the use of the system. More specifically, students provided low ratings to the navigation of the multimedia course. Parlangeli et al. (1999) concluded that the complex structure of the multimedia course indeed affected students' performance.

Addressing the heuristic of *understandable and meaningful symbolic representations* Cronje (2000) investigated the issue of "what extent can some of the methods used by educators be replicated over the internet". To this end this author poses the question: How do adult learners respond to internet-based role-play exercises and youthful methaphors? The challenge was to design a virtual learning environment by using metaphors applying theoretical foundations of constructivism. The results revealed that using metaphors can lead to successful and motivational learning and physical attributes of a classroom can be metaphorically recreated in cyberspace.

Terrell and Dringus (1998) focus their interest on awareness, which is "a combination of visual and conceptual cues given to the learner that increases a learner's immediate sense of presence of others in an online class". While investigating the question of "how awareness can be effectively conveyed online" they propose that awareness metaphors can be conveyed in a number of several ways: number of learners and their locations, CVs, online tours, syllabi and readings, study hall, orientation room, research labs, help center etc.

Learning styles issue is a crucial factor while *supporting personally significant approaches to learning*. Terrell and Dringus (2000) investigated the effect of learning styles on student success in an online learning environment. Kolb's learning theory was the basic theory and the Learning Style Inventory (LSI) the main instrument for assessing the learning styles of the participants in the experiment. The results indicated that students that fit with *Accommodator* learning style dropped from the online program at higher rates.

Checklists

The use of checklists date back to the early days of educational software. Squires and Preece (1999) reported several problems evaluators have found with the use of checklists as predictive evaluation tools. Some of them deal with the focus on technical rather than educational issues. McDougall and Squires (1995) content that these problems are symptomatic of the failure to adopt a situated perspective on the use of educational software. Several attempts have been made to provide a more holistic approach of the use of educational software but they resulted in very extensive checklists, which are tedious to apply (Squires and Preece, 1999). Additionally, an analysis of two well-known checklists (one developed by the National Council for

Educational Technology for evaluating CD-ROMs and the American Microsift Evaluators Guide) reveals the lack of attention to usability and the lack of integration between the two issues (Jones et al., 1999).

2.3 Summary

Despite the efforts of scholars from educational research streams and usability the problem still remains. Dringus (1995b) proposes heuristics without further adaptation to the context of learning environments. Squires and Preece (1999) propose such an adaptation but there is a clear need for further elaboration and empirical validation. Parlangeli et al. (1999), conduct their studies by using usability evaluation methods (Nielsen's heuristics, User evaluation of Interactive Computers System Questionnaire) that were developed to address the needs of a user as a computer user and not as a learner. Notess (2001) stresses that the afore-mentioned methods need additional consideration under the light of on-line learning courses and learning environments.

It can be concluded that educational computing literature seems to deploy naïve and simplistic interpretations of interface design issues. An instructional interface comprises of elements that assist the learner in the task of learning. Online courses and other online learning applications, tools and technologies have to be usable.

Under the auspices of SIG, CHI (2001) it has been reported that: (a) very little quality control and usability testing has been going into the designing of courses and the design of e-learning technologies, typically due to time constraints and low perceived importance of usability, (b) there is a need to focus on how to develop useful and usable tools and environments since so far we are focused more on the technology and not on the pedagogy, and (c) there is very little thought at the decision-making level to usability issues.

The review of learning theories and usability techniques provided evidence regarding the importance of usability while designing online courses. The aim of the next section is to identity which usability attributes affect on-line learning.

3. LEARNERS' REACTIONS TO AN ONLINE COURSE

In order to better understand the users' reaction towards web-based learning a study was carried out. This study relies upon a funded[1] project called "XEXO". This is an abbreviation in Greek, which means a space for Education and Training with no limits. The main objective of the project was to develop a virtual space for lifelong learning. This space is targeted to professionals; even post graduate students who seek additional educational and training opportunities.

3.1 Objectives of the study

One of the objectives of this study was to generate users' reactions while using an online learning course that provides Distance Learning. This course supported three Post-Graduate Masters in three Greek Universities: Athens University of Economics and Business, Technical University of Crete and University of Macedonia. To meet students' needs a Virtual Classroom environment was developed using a well-known e-learning delivery platform, WebCT, and computer based tools.

3.2 Implementation of the Web-based Course

The web-based course comprised of six major topics: Knowledge Management, E-Commerce, Activity Based Costing, Business Process Modeling, Statistical Process Control, and Total Quality Management Each university developed two topics. This integrated web-based course was titled *Organizational Transformation* and was equivalent to 42-hour traditional university graduate-level course. The course aimed at developing students' understanding of the emerging issues concerning the aforementioned topics.

A Virtual Learning Environment (VLE) was developed to support the course using WebCT's Computer Mediated Communication (CMC) and World Wide Web (WWW) Tools. The web-based course ran for 12 weeks. The whole learning environment and the learning content were developed in English. The users were full-time students having English as a second language. Each university assigned one tutor for the scientific coordination and guidance of the course and one administrator for the technical and administrative issues.

Lecture notes and slides were pre-prepared, edited and uploaded into the WebCT environment. Lecture notes were developed as plain text with hyper-links (HTML files). Slides were downloadable as Power Point presentations. Students were supposed to preview the on-line educational material and initiate discussions and questions regarding the course if they felt it was appropriate. Associated information on schedule, assignments, exercises and group-work was also available on-line.

3.3 Questionnaire Design

A questionnaire was designed to collect data regarding users' reactions while using the on-line course. In order to design the questionnaire the results of the literature review presented earlier were used.

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[1] See acknowledgement

The questionnaire consisted of three parts. The first part dealt with demographics questions. The questions related to the user's frequency of use of PC, the Internet, and the e-mail. The second part dealt with the users perception regarding the use of the system. The questions related to the usability of the online course. The user was supposed to answer regarding the importance of each specific usability item using a scale from "1" being least important to "5" being most important.

3.4 Results

It is not the aim of this paper to report all the results of this study. Attention will be paid to the usability attributes that the users rated as highly important while using an online course. To aid the reader the results of the study are divided in three sections: three sections of the questionnaire.

Users Familiarity with the Technology

The results have shown us that the vast majority of students who participated in the experiment were familiar with the use of PCs, Internet and the use of email while they are not really familiar with the use of collaborative tools and most of them prefer the natural, face-to-face way of communication (Table 1).

Use of PC and Internet	
Use of PC on a daily basis	85.37%
Use of PC Few times a week	12.20%
Use of Internet regularly	85.37%
Use of Internet rarely	14.63%
Type of communication methods preferred	
Face-to-face	73.17%
Telephone	17.07%
E-mail	9.76%

Table 1: Familiarity with the Technology

Questions referring to web-based courses' usability

Participants were asked to evaluate the importance of usability attributes of the user interface of an online course. To aid the reader specific usability attributes were enlisted while there was space for free-form comments as well. The results in Figure 1 present the frequencies that the usability attribute was rated as "1" that being most important. It can be derived from the results depicted in Figure 1 that the majority of the respondents were satisfied from the material and variety of content provided. Almost half of them think that navigational fidelity is important. Most of the participants were satisfied with the environment: WebCT. Students felt that they receive good directions allowing them to find their way in the web site. This is obvious since navigation through the web pages of the course is rated as the most important requirement for an online learning course. In terms of activities the students require in order to better attend their distant course they consider the ease of use of the system and the capacity to directly communicate with their instructor as the most important factors.

Free-form comments

Students were asked to propose usability attributes that they consider as significantly useful in a web-based course.

Functionalities	**Frequency**
On-line help and learning performance evaluation	39.47%
Support the use of multimedia files	23.68%
Accessibility	15.79%
Enhancing awareness	10.53%
Efficient searching facility	10.53%

Table 2: Users' Comments

The authors reviewed their answers searching for key words. The results reveal the importance of five additional usability attributes: Support the use of more multimedia files, on-line help and learning performance evaluation, accessibility, enhancing awareness and efficient searching facility (Table 2).

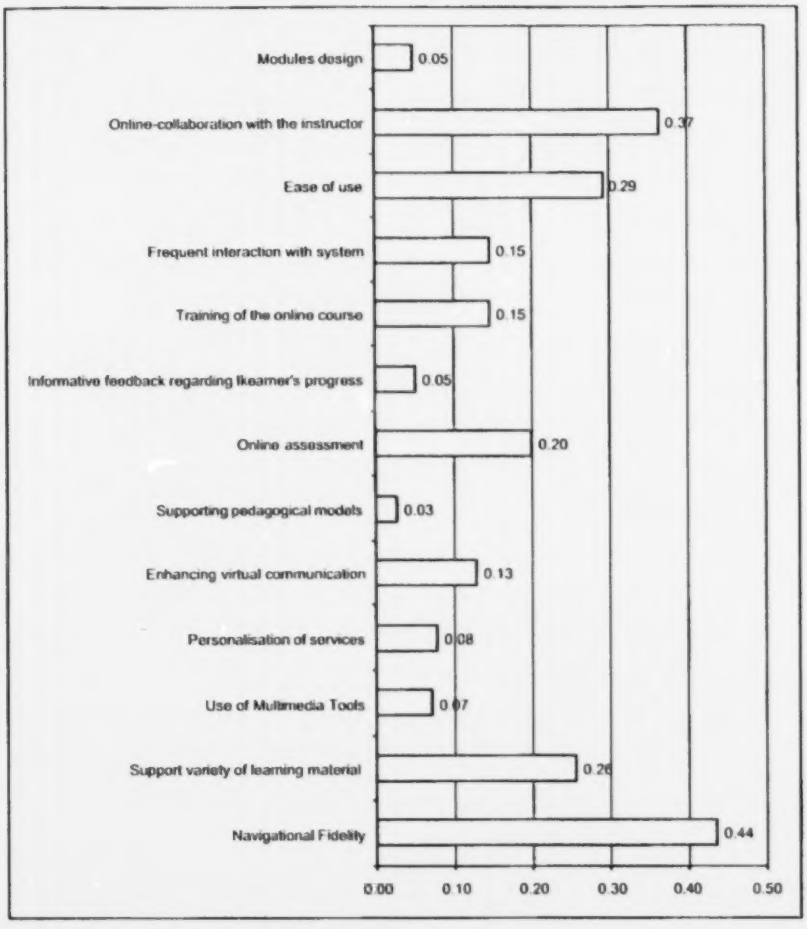

Figure 1: Most important usability attributes

4. CONCLUSIONS

Technological progress allows for further flexibility and power and places the learner in the center of the learning process (Lohr, 2000). In this paper it is argued that designing the interface between a learning environment and the learner is an increasingly critical part of the development of online courses.

First a literature review was presented. The results of the review point towards the direction that scholars currently address the needs of the software environment rather than learning environment where the user and the task are fundamentally different. Current usability techniques as well as learning theories should consider different usability attributes while designing online courses. Learners use these environments to build their expertise. Their interactions with the on-line learning environments may not produce visible results.

Based on these observations this paper examined specific usability attributes that are important to the users while designing online learning courses. To address this issue the results of an experimental study were presented. The results pointed towards five additional usability attributes that need to be addressed by usability researchers and practitioners.

The authors do not mean to say that only these usability attributes should be considered. The results of this study simply provides some light to the continuous efforts towards integrating usability and learning. Understanding which usability attributes should be considered by the designer is an important step towards this integration.

Finally, while there is an abundance of online courses currently available (e.g. Cronje, 2001) still they have not addressed which specific usability attributes an online course should have. Furthermore, the outcome of the learning experience is often not reflected in the interface but on the learner's mind (Lohr, 2000). To this end this paper presented the results of an ongoing

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effort towards investigating and understanding specific usability attributes that reside on the learner's mind and how these can be communicated to the designer.

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